

CLAIMS:

1. A method of treating a seed sample comprising:

subjecting the seed sample to a combination of steam and microwaves operative to heat the seed sample to a treatment temperature effective to inactivate seeds in the seed sample to prevent germination and reproduction of the seeds; and

subjecting the seed sample to an effective ozone concentration operative to significantly degrade herbicides and pesticides present in the seed sample and operative to substantially inactivate all pathogenic organisms present in the seed sample.

2. The method of Claim 1 wherein the treatment temperature is greater than 95° Celsius.
3. The method of any one of Claims 1 and 2 wherein the seed sample is maintained at the treatment temperature for at least 25 minutes.
4. The method of any one of Claims 1 - 4 wherein the effective ozone concentration is between 100 and 5000 parts ozone per million parts air (ppm).
5. The method of any one of Claims 1 - 5 wherein the herbicide or pesticide is one of Malathion, 2,4,-D or thiamethoxam.
6. The method of any one of Claims 1 - 6, wherein the pathogens comprise at least one of viruses, bacteria, fungi, or protozoa.

7. The method of any one of Claims 1 - 7 wherein the seeds are subjected to microwaves and ozone simultaneously.
8. The method of any one of Claims 1 - 7 wherein the seeds are subjected to microwaves first and then subjected to ozone.
9. An apparatus for treating a seed sample such that seeds and associated pathogenic organisms in the seed sample are inactivated, and residual herbicides and pesticides are degraded comprising:

an enclosure operative to house the seed sample during treatment;

a steam source operatively connected to an interior of the enclosure;

a microwave source operative to direct microwaves onto the seed sample in the enclosure;

wherein the steam source and microwave source are, in combination, operative to raise a treatment temperature of the seeds in the seed sample to at least 90°Celsius and maintain the treatment temperature for at least 25 minutes;

an ozone source operative to expose the seeds to an effective ozone concentration sufficient to significantly degrade herbicides and pesticides present in the seed sample and sufficient to substantially inactivate all pathogenic organisms present in the seed sample; and

at least one agitator operative to provide agitation of the seeds in the seed sample for improved exposure to the steam, microwaves, and ozone.

10. The apparatus of Claim 9 comprising an auger conveyor and wherein the enclosure is provided by a tube of the auger conveyor and wherein the at least one agitator is provided by an auger of the auger conveyor rotating inside the tube, and wherein a flow of seeds is directed into an intake of the auger conveyor.
11. The apparatus of Claim 10 wherein the microwave source comprises a plurality of microwave generators spaced along a length of the tube.
12. The apparatus of any one of Claims 10 and 11 wherein the steam source is connected to an interior of the tube in proximity to the intake.
13. The apparatus of any one of Claims 10 - 12 wherein the ozone source is connected to an interior of the tube in proximity to the intake.
14. The apparatus of any one of Claims 10 - 12 wherein the auger conveyor discharges the seeds into a silo.
15. The apparatus of Claim 14 wherein the ozone source is connected to an interior of the silo and generates the effective concentration of ozone inside the silo, and wherein agitation is provided by seeds falling through the ozone inside the silo.
16. The apparatus of any one of Claims 14 and 15 further comprising a dryer operative to blow an air stream through the seeds in the silo to remove moisture therefrom.
17. The apparatus of Claim 16 wherein ozone is injected into the air stream.

18. The apparatus of any one of Claims 10 - 17 further comprising a hopper operatively connected to the intake of the auger conveyor such that seeds placed in the hopper flow into the intake of the auger conveyor when the auger is rotated.
19. The apparatus of Claim 18 wherein the hopper is closed, and wherein steam is directed into the hopper to heat seeds in the hopper.
20. The apparatus of any one of Claims 18 and 19 further comprising a water source operative to add water to seeds in the hopper.
21. The apparatus of any one of Claims 18 - 20 further comprising a steam chamber located between a bottom discharge of the hopper and the intake of the auger conveyor, and wherein the steam source is connected to the steam chamber to direct steam into the steam chamber.
22. The apparatus of any one of Claims 18 - 20 further comprising a shredder roller at the bottom of the hopper operative to break open the seeds.
23. The apparatus of Claim 21 further comprising a shredder roller at the bottom of the hopper above the steam chamber and operative to break open the seeds before they enter the seed chamber.
24. The apparatus of any one of Claims 10 - 23 further comprising a plurality of temperature sensors along a length of the tube, and a temperature control mechanism operative to maintain the treatment temperature of the seeds in the tube at a desired temperature.

25. The apparatus of Claim 24 wherein the temperature control mechanism controls at least one of the microwave source, the steam source, a rate of flow of seeds into the intake of the auger conveyor, and a rotational speed of the auger.
26. The apparatus of any one of Claims 10 - 25 further comprising a timer mechanism operative to adjust to a length of treatment by adjusting a rotational speed of the auger.
27. The apparatus of any one of Claims 9 - 26 further comprising at least one ozone sensor, and an ozone control mechanism operative to maintain the ozone concentration at a desired ozone concentration.
28. The apparatus of Claim 27, wherein the ozone control mechanism maintains the ozone concentration between 100 and 5000 ppm.